APPARATUS AND METHOD FOR MANUFACTURING PANELS FROM WOOD PIECES

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority from U.S. Provisional Application No. 60/226,627 entitled "Apparatus and Method for Manufacturing Panels from Wood Pieces" and filed on August 24, 2000, the contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to the formation of wood panels from a series of wood pieces, and in particular, relates to apparatus and methods for automatically and continuously adhering the wood pieces together.

BACKGROUND OF THE INVENTION

In the manufacture of various products, such as case goods in the furniture industry, it is often desirable to incorporate one or more premanufactured wooden panels in the design of the product. These panels can be made from a monolithic piece of wood or can be built up from certain discrete layers or plies of wood. Another successful approach to forming wood panels involves adhering together a collection of boards having a rectangular cross-section in an edge-to-edge configuration. For example, wooden boards having a thickness of one inch and a width of two inches can be adhered together along their narrower edges to create a panel such as the top of a kitchen table. Another example of panel made from wood pieces is a raised panel of a cabinet door.

Various apparatus have been proposed for automatically creating panels made from adhered wood pieces. For example, U.S. Patent No. 5,240,051 discloses a dual

automated clamp carrier for gluing together panels of wood from wood panel segments. The machine includes a plurality of clamp racks in which panels are clamped so that the individual panel segments can be glued together. For example, as noted in connection with the embodiment of Figure 11, the panels are assembled manually by an operator who first must lift a completed panel from a clamp rack and then stack new panel segments into the clamps on the clamp rack to layout a new panel. (Col. 8, lines 39-41). However, a disadvantage of this approach is that the panels must first be assembled by an operator, which undesirably involves manual labor costs and the risk that the operation will become messy because the operator must handle boards having a wet adhesive applied thereto. In addition, the apparatus can only create panels of limited width (as determined by the spacing of the clamps) and does not provide for the continuous manufacture of wood paneling material.

An improvement on this conventional apparatus is embodied in a continuous gluer machine available from Radio Frequency Services, Inc. in Wilkesboro, North Carolina. In particular, the model CG/RF includes an infeed system for a press that allows continuous production of wooden panels. Wood pieces are supplied from the infeed system with an adhesive applied to a leading edge of the wood piece. Within the press, the leading edge of a wood piece is pressed against the trailing edge of the immediately preceding wood piece. The immediately preceding wood piece is securely clamped and held stationary while the subsequent wood piece with the adhesive applied thereto is pressed against the preceding wood piece. The adhesive is then cured to form a secure bond. Advantageously, the adhesive is curable by way of a radio frequency energy field and the apparatus includes a radio frequency generator as part of the press, which rapidly and securely cures the adhesive between the wood pieces. Thus, the model CG/RF allows the production of a "continuous ribbon" of wood panel material comprising a series of wood pieces adhered together at their edges.

While the model CG/RF has provided great advantages over conventional apparatus, the infeed system requires that the individual wood pieces be moved transversely to the machine direction when applying the adhesive to the edges of the wood pieces. An adhesive extruder is provided adjacent the main conveyor and each wood piece is fed laterally to the conveyor such that a leading edge of the wooden piece is passed along the adhesive extruder and adhesive is applied thereto. However,

in the model CG/RF, wood pieces are supplied to the conveyor in a transverse direction, which can consume potentially valuable floor space adjacent the side of the conveyor. In addition, as would be appreciated by one of ordinary skill in the art, the adhesive application process is dependent on the length of the wood piece in question, which might not provide sufficient line speed.

Another limitation on conventional apparatus relates to subsequent cutting of the wood panels to a desired size. For example, conventional cutting apparatus include a saw capable of cutting in a cross-machine direction to create panels of a predetermined width from the continuous ribbon of wood panel material as the material exits the press. However, in machines that make a single ribbon of wood paneling material, these saws are not capable of easily and quickly being adjusted to cut off panels of varying widths. The ability to cut panels of different predetermined widths at an acceptable manufacturing speed would be highly desirable.

Thus, there is a need in the industry for an apparatus and method that provide continuous production of wooden panels from a series of adhered wood pieces. Such an apparatus would not only allow continuous manufacture of these panels, but would also eliminate the need to supply wood pieces transversely to the main conveyor and would provide automatic application of the adhesive to the edges of the wood pieces. In addition, such an apparatus would also preferably be capable of cutting off panels from the continuous panel material that have different predetermined widths, and would do so at manufacturing speeds.

SUMMARY OF THE INVENTION

The present invention addresses the above needs and achieves other advantages by providing an apparatus and method for manufacturing panels from wood pieces. The apparatus includes several stations that receive, apply adhesive to, crowd, press and cure the wood pieces into a continuous wood panel. In particular, a singulation station is configured to engage an individual one of the wood pieces oriented in a cross-machine direction from an infeed station, present the wood piece to an adhesive station for adhesive application and release the wood piece for crowding at a crowding station into a batch of wood pieces. A press station downwardly presses the batch with an upper platen and further presses the batch in a downstream direction onto the continuous wood panel by extending a clamping device onto an

upstream end of the batch. A radio frequency device of the press station applies radio waves to cure the adhesive between the wood pieces of the batch so as to adhere the wood pieces together and so as to adhere the batch to the continuous wood panel. A cutting station cuts predetermined lengths of individual wood panels from the continuous wood panel.

In one embodiment, the present invention includes an apparatus for adhering a plurality of variable-width wood pieces into a continuous wood panel from which can be cut a plurality of individual wood panels. The apparatus defines a machine direction and includes an infeed station, an adhesive application station, and a singulation station. The infeed station is configured to receive the wood pieces such that the wood pieces are oriented in a cross-machine direction. An adhesive applicator of the adhesive application station is capable of applying adhesive to a side of a wood piece. The singulation station is positioned in proximity to the infeed station and includes an engagement mechanism. The engagement mechanism is configured to engage one of the wood pieces oriented in the cross-machine direction at the infeed station. Further, the engagement mechanism is configured to present the wood piece to the adhesive application station. Presentation of the wood piece to the adhesive application station allows application of the adhesive to the wood piece so that the side of the wood piece to which the adhesive is applied can be adhered to an adjoining wood piece, thereby forming at least part of the continuous wood panel.

In another aspect, the engagement mechanism includes a gripper assembly that has at least one gripper with a plurality of fingers configured to open and close about one of the wood pieces. Preferably, the gripper assembly includes a shaft and the gripper is attached to the shaft. The shaft is rotatable to a first position wherein the gripper is positioned to grip the wood piece from the infeed station. The shaft is also rotatable to a second position, wherein the gripper is positioned to present the wood piece to the adhesive application station for adhesive application. More preferably, the shaft is further rotatable to a third position wherein the gripper is positioned to release the wood piece into a crowding station while maintaining orientation of the wood piece in the cross-machine direction.

In still another aspect, the gripper assembly includes four grippers positioned circumferentially about the shaft spaced 90° apart. In such a configuration, any three of the four grippers can be simultaneously, rotatably positioned at the first, second

and third positions, respectively, by the shaft. Four circumferentially spaced grippers can be grouped in a set, and several sets spaced along a length of the rotatable shaft for gripping wood pieces of variable length.

In yet another aspect, the adhesive application station further includes a gantry beam extending in the cross-machine direction above the singulation station. The adhesive applicator is mounted on the beam for powered sliding movement in the cross-machine direction along a longitudinal edge of the wood piece presented by the singulation station for adhesive application. Preferably, the adhesive applicator is further mounted for powered movement toward and away from the longitudinal edge of the wood piece presented by the singulation station. Further preferably, the adhesive applicator is an adhesive extruder.

In another embodiment, the present invention includes a crowding station positioned downstream from the adhesive application station. The crowding station includes an upstream crowding device and a downstream crowding device. Crowding of the wood pieces into a batch is accomplished by moving the crowding devices together with the wood pieces between them.

In another aspect, the crowding station further comprises a conveying surface that includes an array of parallel slats oriented in the machine direction and defining an array of parallel openings therebetween. The upstream crowding device includes a plurality of pusher fingers at spaced intervals corresponding to the array of the openings. Pushing of the batch downstream is accomplished by interdigitating the pusher fingers into the array of openings and against the upstream edge of the batch. The downstream crowding device includes a plurality of restraining fingers corresponding to the array of openings. Restraining of the batch against the pushing of the upstream device is accomplished by interdigitating the pusher fingers into the array of openings against the downstream edge of the batch of wood pieces.

In yet another embodiment, the present invention includes a press station having an upper platen and a clamping device. The upper platen is positioned to be downwardly moveable onto the batch of wood pieces and the clamping device is configured to clampingly engage edges of the batch of wood pieces. Preferably, the clamping device includes a plurality of offset clamping bars. The offset clamping bars each have a portion extending below a lower surface of the upper platen and have attached thereto a respective one of a plurality of clamping blocks. Clamping

engagement of the upstream edge of the batch of wood pieces is accomplished by actuating the clamping bars so as to move the clamping blocks in a downstream direction. In another aspect, the clamping device further includes a plurality of hydraulic cylinders positioned above the lower surface of the upper platen. The hydraulic cylinders are connected to respective ones of the clamping bars and are operative to actuate the clamping bars. Preferably, the clamping station also includes a radio frequency curing device for curing the adhesive.

Thus, the present invention provides a completely automated apparatus and method for adhering together a number of random width wood pieces quickly and efficiently. Further, the continuous ribbon of wood pieces thus created can be cut to any number of desired widths for various components. As an example, the base of a drawer may be first cut having a width of 12 inches followed by two sides each having a width of 6 inches so that a subsequent assembly operation can complete the manufacture of the drawer.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus described the invention in general terms, reference will now be made to the accompanying drawings and views, which are not necessarily drawn to scale, and wherein:

Figure 1 is a perspective view of the apparatus according to the present invention;

Figure 2 is an enlarged perspective view of a singulation and adhesive application station;

Figure 3 is perspective view of an infeed station and rotary transfer arm;

Figure 4 is a perspective view of the singulation and adhesive application station and also a crowding station;

Figure 5 is an enlarged perspective view of a pair of grippers;

Figure 6 is a perspective view of the crowding station;

Figure 7 is an enlarged perspective view of the crowding station illustrating the crowding of a batch of wood pieces;

Figure 8 is a perspective view of a cutting station according to the present invention;

Figure 9 is an enlarged perspective view of a cutting gantry at the cutting station;

Figure 10 is a perspective view of a downstream end of a gantry frame illustrating a plurality of suspended conveyor chains;

Figure 11 is a perspective view of the underside of an upper platen in the press station;

Figure 12 is a perspective view of the upper side of the upper platen; and

Figure 13 is a perspective view of an offset clamping bar.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

These and other objects and advantages are achieved by the present invention which provides an automated apparatus and method for singulating and gripping the wood pieces and then applying an adhesive along an edge thereof before crowding the pieces together and adhering them in a press. Further, the apparatus and methods of the invention provide the capability of cutting off panel widths of individually selected widths by way of a saw mechanism that can travel in the machine direction relative to the press.

Figure 1 is a perspective view of the apparatus **10** according to the present invention. The apparatus **10** includes various stations for practicing the method according to the present invention including an infeed station **11**, a singulation and adhesive application station **12**, a crowding station **13**, a press station **14**, and a cutting station **15**.

As can be seen in Figure 1, the infeed station **11** includes a plurality of slats **16** extending in a machine direction and a plurality of conveyor chains **17** that are advanced along the top of the slats to form a conveying surface. As can be seen in Figure 3, a collection of wood pieces **20** is placed on the conveyor chains **17** at the

infeed station **11**. The wood pieces **20** can be placed on the conveyor chains **17** either manually by an operator or by some automated device at the upstream end of the infeed station **11**. It is not necessary that the wood pieces **20** are moved onto the conveyor chains **17** laterally and the wood pieces can be placed in the machine direction onto the upstream end of the infeed station. Also, the wood pieces **20** are placed onto the conveyor chains **17** in a dry state before any adhesive has been applied, thus preventing messy drips, smears and the like of adhesive onto the faces of the wood pieces or the machinery.

The wood pieces **20** can be in the form of boards of random width and typically range from 1.25 inches up to 3.5 inches. The wood pieces **20** are typically uniform in thickness and can range from .75 inches to 2 inches thick. The wood pieces **20** are advanced to the end of the infeed station **11** by way of the conveyor chains **17** where they are individually presented to the singulation and adhesive application station **12**.

One advantageous feature of the present invention is the singulation and adhesive application station **12**. For singulating the wood pieces **20** (*i.e.*, individually addressing and processing the wood pieces **20**) the present invention includes a rotary transfer mechanism **21** that has a rotary shaft **22**. The rotary shaft **22** includes a plurality of gripper sets **23,** each of which includes a plurality of grippers **24** for gripping the wood pieces **20**. In the embodiment illustrated, the rotary shaft **22** supports four gripper sets **23**, each of which includes four grippers **24**. The embodiment illustrated is usable with wood pieces having a length up to 60 inches. However, it will be understood that the length of the wood pieces can vary and that the apparatus can be adjusted to accommodate different lengths, such as through the addition or subtraction of gripper sets **23** on the rotary shaft **22**.

As can be most clearly in Figure 2, each of the grippers **24** includes opposing pairs of pivotable fingers **25** that can be selectively opened and closed by retracting or extending a pair of cylinders **26**. The grippers are also provided with stops **27** that prevent the wood pieces **20** from extending too far in between the fingers **25**.

Positioned over the rotary transfer mechanism **21** is an adhesive applicator **30**, which is slidably mounted on a beam **31**. The adhesive applicator **30** is connected to a source of adhesive (not shown) and is capable of traversing the beam **31** to apply adhesive to an edge of a wood piece **20** when oriented vertically subjacent to the

adhesive applicator **30** by the rotary transfer mechanism **21**, as discussed in more detail below. The adhesive is preferably a radio frequency curable adhesive of a type known in the industry.

Thus, in operation, the wood pieces **20** are sequentially presented to the rotary transfer mechanism **21**. The grippers **24** of each gripper set that face horizontally and upstream (i.e., those in the 9 o'clock position when viewed from the right-hand side of the machine) are closed by actuation of the cylinders **26**. The wood pieces **20** are held by the fingers **25** and against the stops **27**. The rotary transfer mechanism **21** is then rotated 90° in the clockwise direction (again when viewed from the right-hand side of the machine) so that the wood piece **20** is presented in a vertical configuration below the adhesive applicator beam **31**. The rotary transfer mechanism **21** is momentarily stopped and the adhesive applicator **30** is traversed across the beam **31** to apply adhesive along the entire upper edge of the wood piece **20**. One or more sensors **39** are provided in conjunction with the adhesive applicator **30** to sense the distance between the applicator and the edge of the wood piece so that the adhesive application can be adjusted accordingly by raising or lowering the applicator. The adhesive applicator **30** is preferably an adhesive extruder.

After the adhesive has been applied, the rotary transfer mechanism **21** is again rotated in a clockwise direction by 90° so that the wood pieces are presented to the crowding station **13**. The grippers **24** are then released and the wood pieces **20** are free to travel through the crowding station **13**. Of course, it will be appreciated that the grippers **24** of each set **23** in each of the 9 o'clock, 12 o'clock and 3 o'clock positions operate simultaneously such that two or three wood pieces **20** are always engaged by the rotary transfer mechanism **21**. One advantage of the singulation and adhesive application station **12** of the present invention is that no manual handling of the wood pieces **20** is required during the adhesive operation and, further, the wood pieces are not required to be moved transversely with respect to the machine direction for the adhesive to be applied. In the present invention, the entire adhesive application process is automated.

At the crowding station **13** the wood pieces **20** are conveyed on further conveyor chains **17** which run along the top of respective slats **16**. As can be best seen in Figures 4, 6 and 7, the wood pieces **20** are crowded together at the crowding station **13** such that the leading edge of each wood piece, to which the adhesive was

applied by the adhesive applicator **30**, is abutted against the trailing edge of the immediately preceding wood piece **20**. The wood pieces **20** are restrained on the conveyor chains **17** by a downstream set of pivotable restraining fingers **37** mounted under the top surface of the slats **16**. After a batch has been accumulated, the restraining fingers **37** are pivoted downwardly and the batch is pushed into the press station **14** by a set of pusher fingers **32**.

The pusher fingers **32** are mounted on a beam **33** which provides for rotation of the pusher fingers about an axis parallel to the beam so that, when pivoted upwardly, the pusher fingers and beam allow wood pieces **20** to pass thereunder while a batch is being accumulated. The pusher fingers **32** can then be rotated downwardly between the slats **16** and the beam **33** is advanced downstream in the machine direction which causes the pusher fingers to engage the wood pieces **20** and crowd the wood pieces **20** together at the press station **14**.

The pusher fingers **32** advantageously square each batch of wood pieces after the batch has entered the press station **14**. Certain of the wood pieces do not have exactly parallel edges and thus have a tapered profile. Thus, if enough successive wood pieces are tapered in the same direction, it is possible in conventional machines to affect the alignment of the resultant ribbon of wood paneling material and the ribbon can have an undesirable curved shape when viewed from above. The present invention is not susceptible to such cumulative errors, however, because the pusher fingers **32** ensure proper alignment of each batch individually.

The press station is provided with an upstream set of pivotable restraining fingers **38** also mounted under the top surface of the slats **16**. The upstream restraining fingers **38** act in concert with the downstream restraining fingers **37** in an escapement fashion to ensure that the wood pieces **20** are all properly batched.

In the press station **14** the wood pieces **20** are held tightly together while a radio frequency field is applied to the wood pieces **20** A device as illustrated in Figures 11-13 is used to clamp the wood pieces **20** together in the press station **14** and includes an upper platen **44** having a generally flat lower surface, as can be seen most clearly in Figure 11. The upper platen **44** can be raised and lowered onto the wood pieces under the hood **46** of the press station **14**. The upper platen **44** supports on its upper surface a plurality of hydraulic cylinders **47** that are each operatively connected to a respective offset clamping bar **45**. At the opposite end of each offset clamping

bar **45** is a clamping block **48** that is configured to engage one of the end wood pieces in each batch. Opposite fixed clamping blocks (not shown) are also supported on the upper platen **44** and are engaged by the other of the end wood pieces. After the batch of wood is in the press station **14**, the hood **46** and upper platen **44** are lowered and the clamping blocks straddle both ends or sides of the batch of wood. The hydraulic cylinders **47** are then activated which apply the desired clamping pressure to the wood pieces while the adhesive is cured. This pressure can be in the range of 150-200 psi. An advantage of this arrangement is that the hydraulic cylinders are arranged above the upper platen, which is unlike some conventional apparatus that arrange the cylinders to one side or the other of the wood batch and which entails the use of additional floor space to avoid interference with the feeding mechanism.

The radio frequency field is created by a radio frequency generator (not shown) that causes the radio frequency curable adhesive to cure quickly, typically within a matter of seconds. Radio frequency cured adhesives are conventional in the art and are not explained further herein. However, it should be noted that, as each batch of wood pieces **20** is accumulated in the crowding station, the trailing edge of one batch is adhered to the leading edge of a subsequent batch. More particularly, the wood piece at the trailing end of the batch in the press station **14** is briefly clamped in place while the wood piece at the leading end of the subsequent batch is pressed thereagainst by the pusher fingers **32**. In this manner, even though the radio frequency field preferably is generated intermittently for successive batches of wood pieces, it is possible to create a continuous ribbon of wood pieces exiting from the downstream end of the press station **14.**

Another advantageous feature of the present invention is the cutting station **15** which includes a rotary saw blade **34** for cutting from under the wood in a cross-machine direction, as is best seen in Figure 1. The saw blade **34** is mounted for movement in the cross-machine direction on a gantry **35** and may be provided with a dust chute for removal of sawdust. The gantry **35** is itself movable along a gantry frame **36** in the machine direction. The saw blade **34** and gantry **35** are operatively connected to a processor that allows selected panels to be cut to desired widths. In other words, the gantry **35** is moved back and forth along the frame **36** to a position corresponding to the desired width of a panel and the saw blade **34** is then moved transversely to the machine direction to cut the desired panel width.

The cutting station **15** is provided with parallel conveyor chains **40** that extend in the machine direction and are also movable in the downstream direction. However, the conveyor chains **40** in the cutting station **15** do not ride along the top of slats but are instead drawn relatively tightly between the upstream and downstream ends of the gantry frame **36**. Guide wheels **41** are provided at the corners of the gantry **35** and allow the conveyor chains **40** to be routed underneath and around the gantry **35**. In this fashion, the gantry **35** can be moved entirely independently of the conveyor chains **40** and the wood pieces **20** will always be supported throughout their travel through the cutting station **15** by the conveyor chains.

A guard **42** travels on the gantry **35** above the saw blade **34** and protects operators and personnel from contact with the saw blade. The guard **42** also serves a function of holding the ribbon of wood pieces firmly against the gantry during the sawing operation. A plurality of cylinders **43** is provided for raising and lowering the guard **42** when access to the saw blade is desirable and/or the cut wood panels are to be released. In Figures 8 and 9 the cylinders **43** and guard **42** are shown in a lowered position whereas in Figure 1 the cylinders and guard are shown in a raised position. At the end of cutting station **15**, the manufactured panels can be removed and conveyed to finishing operations such as planing, sanding, staining, etc.

Thus, the present invention provides a completely automated apparatus and method for adhering together a number of random width wood pieces quickly and efficiently. Further, the continuous ribbon of wood pieces thus created can be cut to any number of desired widths for various components. As an example, the base of a drawer may be first cut having a width of 12 inches followed by two sides each having a width of 6 inches so that a subsequent assembly operation can complete the manufacture of the drawer.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.